

# Multi-scale Analysis in Dynamical Systems

## Winter School and PhD course

Technical University of Denmark,  
Department of Applied Mathematics and Computer Science

## Date

9th December – 13th December, 2013

## Location

Technical University of Denmark, Kgs. Lyngby (Copenhagen),  
Denmark. [www.dtu.dk](http://www.dtu.dk)

## Course Description

The course will focus on the analysis of multiscale dynamical systems.  
The course objectives are:

- Explain and apply Fenichel's geometrical theory of hyperbolic slow manifolds in slow-fast systems
- Describe geometry near non-hyperbolic points on slow manifolds
- Explain and apply reduction methods in multi-scale systems
- Perform numerical continuation in slow-fast systems
- Explain equation-free methods and identify situations where these methods are applicable
- Analyze multi-scale problems arising from scientific or engineering problems
- Use multi-scale analysis to make conclusions about a concrete problem in science or engineering
- Write a well-structured report that concisely describes the findings from working on a multi-scale problem.

The course work includes study of preparatory reading material before course start. Integral parts of the course are exercises and project work.

## Course Homepage

<http://www.mat.dtu.dk/people/J.Starke/multiscalecourse2013>

## Organizers

Kristian Uldall Kristiansen, Morten Brøns and Jens Starke,  
Department of Applied Mathematics and Computer Science, Technical University of Denmark.

## Lecturers

Antonios Zagaris  
(University of Twente, Applied Analysis and Mathematical Physics, Netherlands)  
*Computational Method in Multi-scale Systems*

Peter Szmolyan  
(TU Vienna, Institut für Analysis und Scientific Computing, Austria)  
*Advanced Singular Perturbation Theory*

Mathieu Desroches  
(INRIA, Paris-Rocquencourt Centre, France)  
*Continuation in Slow-Fast Systems*

Jan Sieber  
(University of Exeter, College of Engineering, Mathematics and Physical Sciences, UK)  
*Equation-free methods*

Each lecturer will formulate a project and each participant must select one project to work on after the end of the course week.

## Participants

The course is designed for Ph.D.-students and final-year graduate students being familiar with the basic concepts of dynamical systems. James Meiss's book: Differentiable Dynamical Systems is a relevant reference.

## Working Load

The course gives 5 ECTS corresponding to approximately 130 hours in total, which includes work during the course period at DTU (lectures, exercises, and discussions) as well as preparatory required reading before course start and project work after the course week.

## Study Material

Course material will be provided to the participants approximately a month before course start. Preparatory reading of the material is required.

## Language

All lectures will be given in English.

## Evaluation

To pass the course, active participation in all activities is required; this includes discussions, exercises, and project work. A project report must be handed on the 20th December 2013. The course is passed/not passed. ECTS points: 5.

## Registration

Secretariat, Att. Hanne Jensen, Department of Applied Mathematics and Compute Science, Technical University of Denmark, Building 303B, DK-2800 Kgs. Lyngby, Denmark. Phone: (+45) 4525 3353, E-mail: [hmmj@dtu.dk](mailto:hmmj@dtu.dk).

## Registration Fee

There is a no registration fee for students enrolled at universities and public research institutions. There is however a 50 EUROS contribution towards expenses for course material, coffee and tea.

## Deadlines

Applicants should submit a request for registration to be at the hands of the course secretariat no later than six weeks before course start. Information on enrollment will be posted within a week after this date.

## Housing

Information about housing will be available later.

## Support

This course is supported by the PhD-school ITMAN.